Space Weather Technical Forecast

Issued on Friday, 09 September 2022 at 13:12 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Active electron fluence throughout.

Analysis of Space Weather Activity over past 24 hours

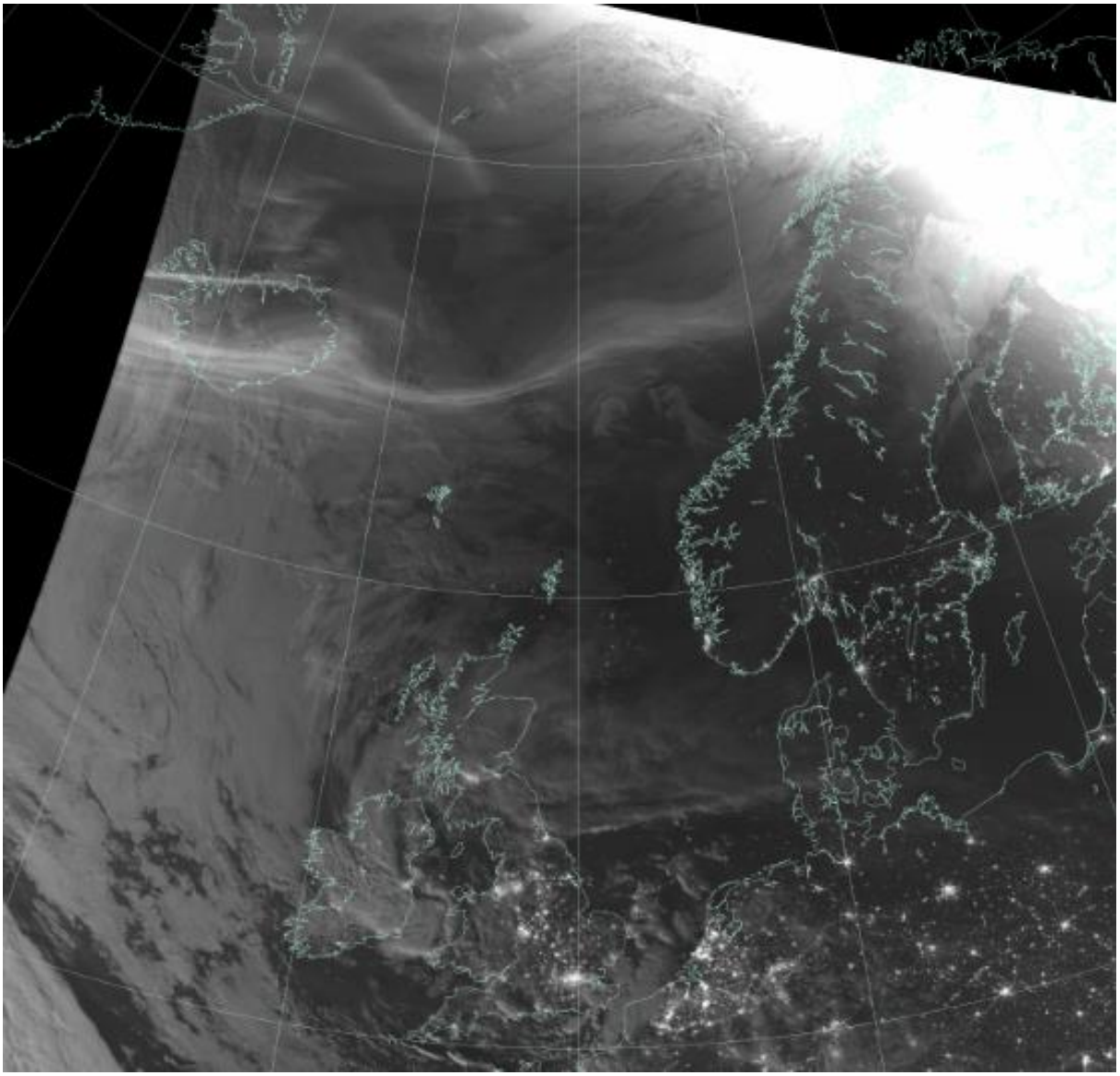

Figure 0: 0.7um infra-red corrected low-light level satellite imagery from NPP at 09/0103UTC, showing a slightly enhanced auroral oval traversing the Arctic Ocean between Iceland and Norway. The edge of the overpass swathe appears black, and the day-night terminator is visible over Scandinavia.

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Solar Activity: Solar activity was Low over the past 24 hours, with X-ray activity at GOES16 showing an overall slight decrease in high B-class, peppered with occasional low-magnitude C-class flares. The largest of these flares was a C2.1 appeared to emanate from recently numbered AR3098 at 08/1711UTC. This was one of two main sunspot regions on the disc in terms of complexity, with this group finishing the 24 hours as a Cri/Beta after some spot proliferation and spreading, although both eased with time. The other main occupant of the disc was AR3096 to its east, although this group's designation of Dsi/Beta failed to bear fruit, even as its intermediate spots developed penumbra.

There were up to seven regions on the disc all in, however with the above exceptions these were all stable or else decaying unremarkable magnetic dipoles or else (apparent) monopoles.

Coronagraph imagery in the period was dominated by emissions from behind each limb in the southern solar hemisphere - initially a slow but visually large event from behind the southwest horizon during the UTC afternoon of 08 September, and a second more energetic but narrower emission from around the eastern limb during the same evening. Neither of these above events should affect Earth, and there was therefore no evidence of any Earth-directed Coronal Mass Ejections (CMEs).

Solar Wind / Geomagnetic Activity: The solar wind, as measured by DSCOVR and ACE at L1, was indicative of a very slowly waning coronal hole HSS from CH20/+.

The solar wind speed showed an erratic tendency from Elevated into Slightly Elevated territory in the past 24 hours, falling from values near 550km/s to 475. The solar wind density for the same period was near-average in single figures ppcc, while the IMF stayed within background at 7nT. The north-south component of the IMF was more noteworthy, ranging between +5 and -7nT, but as in recent days spending protracted periods of time between co-alignment and anti-alignment with the Earth's field, with a noteworthy negative Bz spell from 09/0600UTC. The phi angle was mainly away from the Sun (positive), but with brief dalliances in negative territory around 03UTC and 10UTC.

The net result of the above solar wind measures was Unsettled to Active, with a provisional peak Kp of 4+ in the 21-24UTC interval.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES16, was at Background levels, with a very slight enhancement below even 1pfu at 10MeV perhaps related to the western rearward-directed CME.

The high energy electron flux (greater than 2 MeV) was at High levels, with a peak of 22,580 pfu at 08/1800UTC. The 24-hour integrated electron fluence remained above the Active (1e8 integrated pfu) threshold on a rising and then falling trend, with 8.81e8 integrated pfu observed at 09/0001UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is Expected to be largely Low, with a daily Slight Chance of becoming Moderate with isolated M-class flares, most likely from AR3098 or perhaps AR3096.

Solar Wind / Geomagnetic Activity: No Earth-directed CMEs currently feature in the forecast.

The current fast wind regime is the only one to feature in the coming four days, and as such isolated Active intervals should become less frequent into the UTC weekend, reliably Quiet from day three, Sunday 11 September.

Energetic Particles / Solar Radiation: High energy protons (greater than 10 MeV) are

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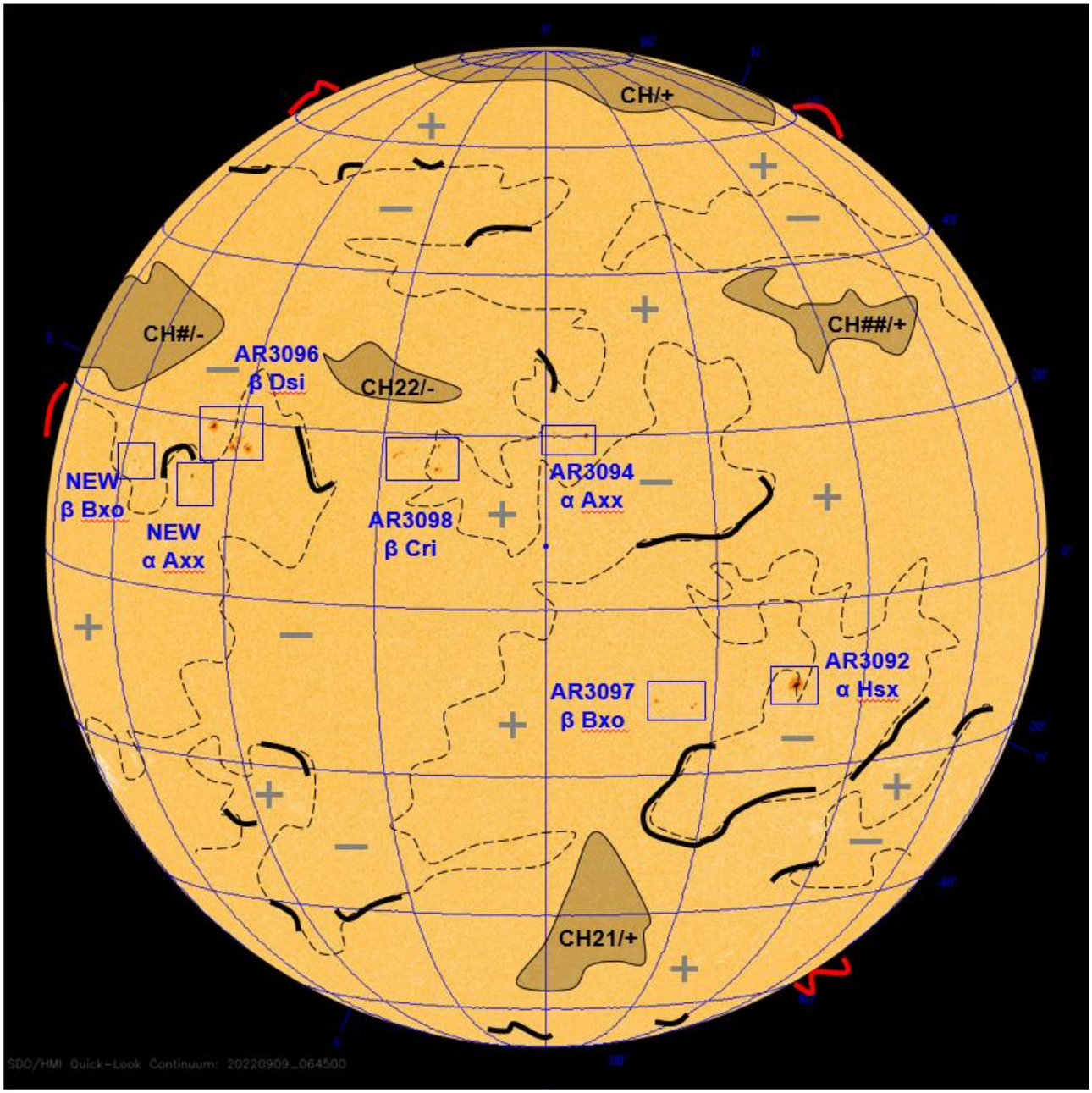
expected to remain below S1/Minor radiation storm levels.

The high energy (greater than 2 MeV) electron flux is currently at High levels and is likely to remain High. The corresponding 24-hour fluence is expected to persist above the Active (1e8 integrated pfu) threshold, although a declining trend is likely.

Figure 1. Solar Analysis Valid 09/0645UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

No CMEs feature in this forecast period.

The only coronal hole impinging on Earth in the period is the current feature - identified with CH20/+ or else a diffuse feature immediately to tits northeast on the northwest disc. This feature has long-since peaked in all likelihood, and a continuation of the currently observed trend of an erratic decrease towards a slow regime should prevail, probably becoming reliably Quiet from day three, Sunday 11 September.

Also of note is the presence of numerous large filaments across the solar disc at present, particularly in the southern solar hemisphere. While there is nothing to suggest that any emissions are likely in the period, these do present a risk of injecting transients into the forecast and will be monitored as a result.

In the longer term, persistence would have a resurgent solar wind speed as due on Tuesday 13 September. While this date or perhaps the middle of the next week may still see the next coronal hole arrive (the analogous feature currently numbered CH22/- in the northeastern quadrant), this visually appears as a faded remnant of its former self. In addition to this hole's smaller stature, its negative polarity should see any geomagnetic activity suitably damped given the impending autumnal equinox (the annual minimum potency for such features).

All considered, for the coming four days, isolated Active intervals should become less frequent into the UTC weekend, becoming reliably Quiet from day three, Sunday 11 September.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	20	1	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil.

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Figure 2: NSO GONG H-Alpha imagery from El Teide observatory, showing numerous large filaments across the disc, particularly in the southwestern quadrant. These are some of the main areas of monitoring at present.

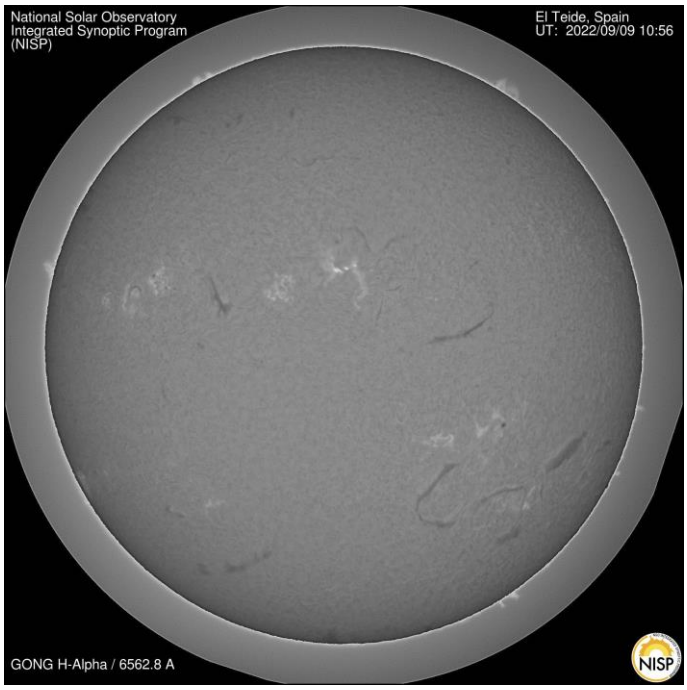
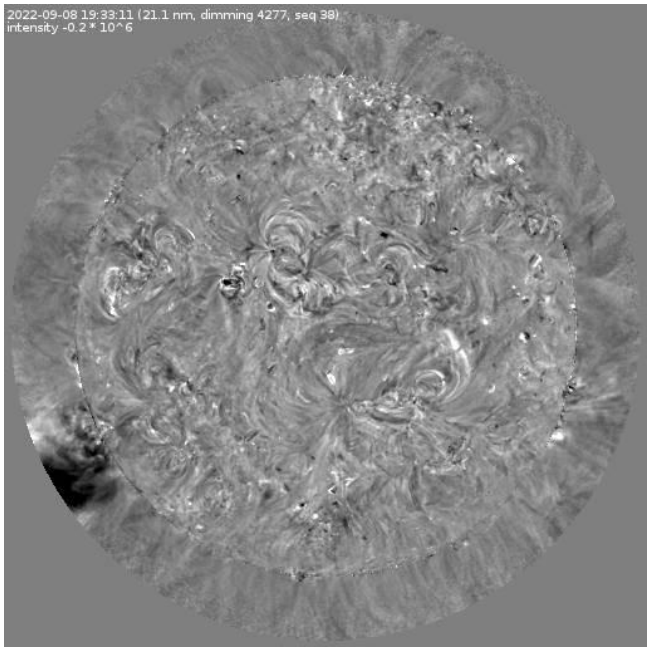


Figure 3: Time-integrated AIA 211 imagery of a southeast solar horizon dimming associated with one of the two far-sided CMEs observed in the period. This is not expected to affect Earth. Image processing courtesy of SIDC ROB.



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Radio Blackouts - X-Ray Flares:

There are now up to seven sunspot regions on the disc, with a plage in the southeast perhaps likely to present an eighth in the coming hours.

Despite the weight of numbers of current and potential groups, almost all of these present as magnetically unipolar or else simple dipolar regions. Of the current disc, AR3098 and AR3096 are on paper most liable to flare, however their recent behaviour and slowing of their growth trends perhaps suggest that current activity is near their peak in their current guise.

The far side of the Sun potentially harbours the surviving remnants of Ex-3088 in the southeast a couple of days behind the limb - this may be the source of the fast and narrow CME observed from this sector in the past 24 hours, however this is conjecture given the absence of imagery for this location. This may be something to watch later in the UTC weekend, however for now a flat 5% risk of M-class flares is maintained.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	5	5	5	5
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 4: Helioviewer.org-generated difference imagery for HMIIF between 08/0600UTC and 09/0600UTC, showing evolution of the current facing-side sunspot groups. Current positions are shown in black, with those 24 hours prior in white. AR3096 and AR3098 in the upper left of the image can be seen to be the most changed. Shown for scale are both the Earth and the eastern limb, the latter also harbouring a (faintly visible) plage and potential new sunspot group (TBC).

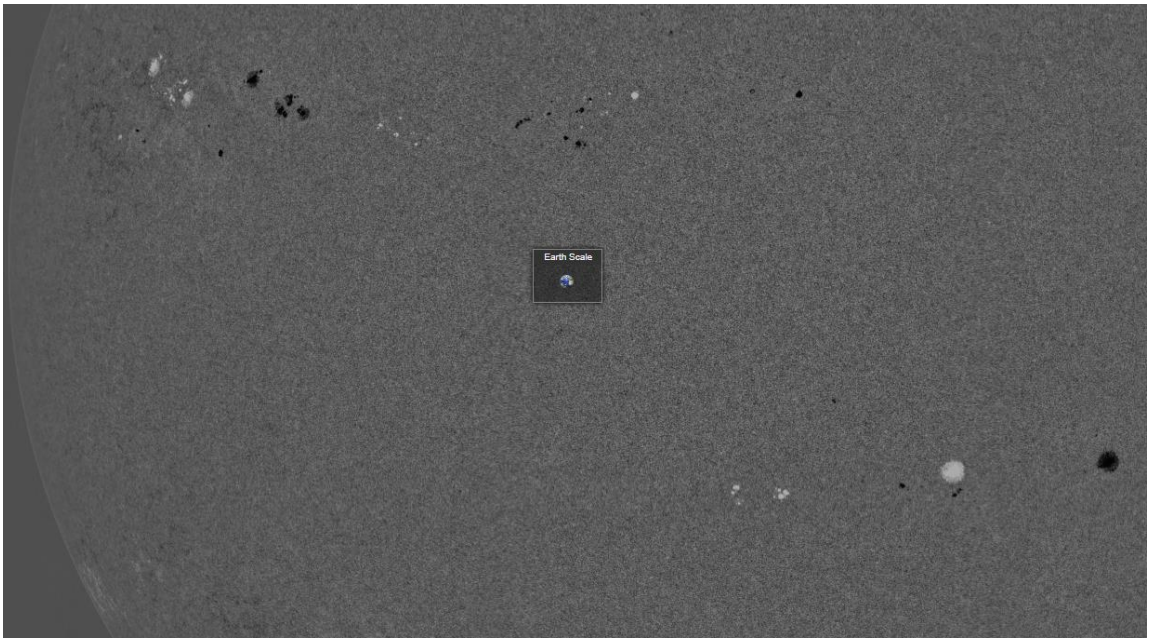

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Figure 5: SIDC ROB diagnostic of X-ray flare locations in the past 48 hours – the majority of which can be tied to AR3098 and to a lesser extent the southeastern limb and AR3096.

Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10MeV) remains near Background values, with a very slight enhancement now evident (below even 1pfu at 10MeV). The source of this slight increase is not immediately apparent, but may be tied to the rearward-directed western solar hemisphere CME of 08 September, with a relatively soft onset and rise seen. Repeats of such activity are not considered likely, and little change is expected given the lack of complex regions in potentially geoeffective locations.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	1	1	1	1
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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High Energy Electrons Event (≥ 2MeV):

High energy electrons have shown a significant response to the long-lasting high speed stream from coronal hole 20, and perhaps now its vestigial successor on the northwest disc (unnumbered). The recent tendency in solar wind speed has been erratic, but overall with a slight downward tendency, such that possible mechanisms to reach Very Active fluence are becoming harder to justify, despite proximity to the threshold.

Overall, further incidences of geomagnetic activity earlier in the period ought to dent flux levels at GEO into the coming UTC weekend, with the diurnal oscillation probably recovering its previous highs to a lesser degree with each event. While Active fluence may well survive the whole four-day period, levels should show a slight decrease overall.

GEO Electron Environment	**Level (cm^{-2} sr^{-1} day^{-1})**	**Past 24 Hours (Yes/No)**	**Day 1 (00-24 UTC)**	**Day 2 (00-24 UTC)**	**Day 3 (00-24 UTC)**	**Day 4 (00-24 UTC)**
Probability (Exceedance)			**(%)**	**(%)**	**(%)**	**(%)**
Active	**≥ 2 MeV ≥ $1x10^{8}$**	Yes	100	90	90	80
Very Active	**≥ 2 MeV ≥ $1x10^{9}$**	No	20	10	5	5

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